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ABSTRACT:

A construction management system includes a handheld computer adapted to collect construction data from the field; a planning system to track budgetary information; a design system to perform site engineering assessment; and a construction system to track material consumption and progress for each project, the construction system adapted to receive data collected from the handheld computer, store daily project reports and generate key indicator

reports.

BRIEF SUMMARY:

BACKGROUND OF THE INVENTION

[0001] The present invention generally relates to a quality assurance control system to manage construction projects.

[0002] In many large-scale construction projects, a developer needs to provide construction bid specification preparation, which is evaluated before the developer is awarded a contract. Once the developer receives the contract, various construction management and contract administration practices need to be implemented. These practices include developing a plan that will allow the effective coordination of operations, construction, and engineering personnel. The plan in turn specifies procedures for field inspection, supervision, and testing. The need for project planning becomes even more important for governmental projects and is usually mandated by law for an incorporated political unit or municipality or community.

[0003] Traditionally, project managers have been using spreadsheets, databases, and other software tools for years in order to track the information they need to run their jobs. Much of that information is originally accumulated in file folders and manual logs. A significantly large amount of information is created and used during a life-cycle of a construction project (i.e., from a planning stage through design and construction stages to facility management).

[0004] Various computer systems (e.g., CAD system, analytical system, analytical system, simulation system, etc.) have been developed and introduced by construction firms. However, many of these systems are effective only within certain narrow application domains so that transmission of

information
between different domains is realized by linking together the applications.

[0005] To illustrate, in order to accomplish such a construction project, each
person in charge shares the project data with others, and keeps such data for
his own use, and based on his allotted share of the work. However, the project
activities are interrelated with each other in a complex manner so that it is
very difficult for the persons in charge to have information in common with
each other. Such complexity is because the project data is stored, retrieved,
computed and updated as the project progresses from the viewpoint of each
person in charge with respect to each particular piece of information.

[0006] Although computerized spreadsheets and databases offered significant
productivity gains in modeling complex data, none was as intuitive to use as
the old, but familiar paper and pencil. To use the new technology, the user
had to type information into the cells of the spreadsheet. In the hand of
inexperienced users, the data entry aspect was unpleasant. Further, the
verification for correct data entry was time consuming. Additionally, the user
had to master many complex and arbitrary operations. Furthermore, conventional
computerized spreadsheets and databases still required users to manually enter
the information.

[0007] Recently, portable computing appliances such as those offered by Palm
Computing, Inc. offer the ability to capture data on the spot. However,
portable computing appliances must balance the conflicting requirements of the
readability of the displayed characters and the size of their display screens.
On one hand, the portability requirement implied that the screen be small. On
the other hand, the readability requirement pushed in the opposite

direction
and dictated that the display area be as large as possible. However, as
computing appliances with large screens consumed more power, were more fragile,
expensive and bulkier, most portable computers offered only a small display
surface. The selection of a small display size restricted the user into making
undesirable choices between displaying either larger characters or more
information.

SUMMARY

[0008] A construction management system includes a handheld computer adapted to
collect construction data from the field; a planning system to track budgetary
information; a design system to perform site engineering assessment; and a
construction system to track material consumption and progress for each
project, the construction system adapted to receive data collected from the
handheld computer, store daily project reports and generate key indicator
reports.

[0009] Implementations of the system may include one or more of the following.
The handheld computer collects work in progress data such as project and
contract identification, inspector identification, item number, location, and
one or more description of activities. The the handheld computer collects
labor related information such as labor type, quantity and hours. The handheld
computer also collects equipment information such as equipment type, quantity,
hours in use and stand-by hours. The handheld computer can also collect
submittal information such as weather condition, comments, and an inspector
name. The handheld computer sends collected information to a server. The
collected information may be sent wirelessly using a wireless handheld unit.
Alternatively, a modem coupled to the handheld computer can be used

to transmit
the information. Also, a hot-sync cradle coupleable to the handheld computer
can be used for hot-syncing the collected information for transmission to a
server.

[0010] Advantages of the system may include one or more of the following. The
system provides comprehensive program and construction management services
supporting teams of engineers, construction managers, schedulers, cost control
engineers, estimators, and document control specialists to oversee the
planning, design and construction of large-scale transportation and public work
projects.

[0011] The system facilitates teamwork between the staff of the owner, designer
and contractors of a project. During the initial development phase of a
project, the system expedites the selection of a design team and the
development of a realistic, and achievable, budget and schedule. During this
phase the system also assists in defining the design criteria for the project
to meet the expectations of the owner.

[0012] In the Design Development Phase, the system facilitates and manages
quality control/quality assurance for the project. At critical phases during
design phase, the system supports updating of the project schedule and budget
in relation to the level of design. The purpose of these updates is to
maintain the original project scope or to identify, in a timely manner the
necessity of revisions to the plan. The system also conducts constructability
reviews throughout the design process. The system also documents all aspects
of a project. Within a given organization, all projects may be consistently
documented. In short, the notebook process provides a standardized, easy to
use, project development process.

[0013] The system manages the construction of multiple projects using inexpensive handheld computers communicating with a server. The handheld computer stores daily field journals such as work progress of unit bid items and contract deliverables, manpower utilization, equipment utilization, and general information including weather, temperature, remarks, and the inspector's name. The handheld computer also captures an inspection checklist and generates Punch list items, tracks Punch list items, takes facility inventory, and tracks facility repairs and cost estimates. The handheld also handles project documentation, such as project specifications, industry specifications, and drawing logs, among others.

[0014] The system is an integrated program management system where the processes for planning process, designing and constructing operations share the same information. The system can also perform program management where a large construction program can have a plurality of projects within that program. The system can manage the process of planning long range budget plans and after the plans have been approved, the system can specify for a particular year the projects that are in a design phase where an architect or engineering firm performs initial site feasibility studies, performs the design work so that the project can receive bids from construction companies. The system can also provide project tracking on a day to day basis. The tracking can be done using an inspection system field notebook system that tracks the progress of the project on a day to day basis as well as values that are paid to the contractor so that correct intermediate progress payments can be made for a particular project.

[0015] The system is as easy to use as the pen and paper approach and provides information integration advantages, including the ability to capture data from

scanners, barcode readers, or the Internet. Furthermore, as portable computers
are typically deployed in field applications by service providers where
employees are scattered over a wide geographic area, the information advantages
arising from integrating data collected from handheld computers include an
ability to link information generated at the client's site with follow-up
discussions and letters necessary to close the transaction enhances the
efficiency of field personnel. The handheld computer is small and inexpensive.
Thus, field personnel can perform data collection without carrying a relatively
bulky laptop or notebook computer.

[0016] Other advantages of the invention may include one or more of the
following. The system provides an efficient, integrated system for keeping
track of job details that are constantly changing. The management of proposal
submittals becomes convenient. Further, the tracking submittal responses or
approvals is streamlined. The submittals, transmittals, change orders, request
for information, meeting minutes, daily reports, activity logs, and other job
related documents are organized and instantly searchable. The system enables
information related to a building production to be managed unitarily by making
use of a computer and to properly transmit production information generated at
each stage of the production to the next process. The field-based project
managers can be constantly in touch with the main office via phone, fax, or
courier to ensure that their job information is accurate and up-to-date.
Production and cost information from the system can be sent directly to the
accounting staff for entry into the job costing and accounting software.
Further, the system avoids requiring duplicate entries to be made.

DRAWING DESCRIPTION:

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a diagram illustrating an integrated construction project management system.

[0018] FIG. 2 is a diagram illustrating a networked computer system for handling an integrated construction management system.

[0019] FIG. 3 is a diagram illustrating major modules associated with an integrated construction management system.

[0020] FIG. 4 is a diagram illustrating a system for handling information updates from field personnel.

[0021] FIG. 5 is a diagram illustrating a planning-design-construction process flow.

[0022] FIG. 6 is a diagram illustrating processing of a capital improvement plan.

[0023] FIGS. 7a-7c are flowcharts illustrating two design phases.

[0024] FIG. 8 is a diagram illustrating one sequence of processing data in an integrated construction management system.

[0025] FIG. 9 is a diagram of an exemplary handheld computer to collect field data.

[0026] FIG. 10 is a flowchart illustrating operations performed on the handheld computer of FIG. 9.

[0027] FIGS. 11-18 are exemplary user interfaces on the handheld computer in collecting data in the field.

[0028] FIG. 19 shows an exemplary process 600 to handle quality assurance checking for one or more construction projects.

[0029] FIGS. 20-25 show exemplary user interfaces for the process of FIG. 19.

DETAILED DESCRIPTION:

DESCRIPTION

[0030] Referring now to FIG. 1, a project control system for providing program management of capital improvement projects is shown. The system 100 consists of a plurality of modules, a planning system 102, a design system 104, and a construction system 106. The project control system can handle multiple projects in their planning phases, design phases and construction phases. The planning system 102 is a budgetary system that tracks finding sources, the allocation of the funding sources, and scheduling information. The planning system 102 also maintains data relating to preliminary site feasibility studies such as estimates of the cost of the project.

[0031] The design system 104 allows the user to perform detailed site assessments. The user can check for a variety of concerns, for example environmental concerns. The design system 104 also allows the user to start a preliminary design that meets predefined requirements on a particular project. The design system 104 also performs contract management aspects of the design contract, including tracking whether a design engineering company or an architectural firm has delivered certain items. The design system 104 also performs contract management and archives any court document control such as correspondence between an owner and a design firm.

[0032] The construction system 106 tracks the actual materials consumed and the progress of the project. For example, data relating to construction items previously bid upon can be reviewed in determining the quantity of material

delivered and the payment to a particular contractor for its construction items. The system 106 can track on a daily basis the quantities of the materials being delivered to the job site, the progress of the work and the resulting pay estimate sheets. The construction system 106 also performs various contract management functions, including archiving all contract documents and correspondence associated with a particular construction management construction firm.

[0033] In combination, the planning system 102, the design system 104 and the construction system 106 allow an organization with multiple projects to see an overall project schedule so that any level of details can be reviewed in each one of these phases.

[0034] FIG. 2 illustrates an exemplary hardware configuration system 110 for executing the modules of FIG. 1. In the system of FIG. 2, one or more handheld computers 112, 114 and 116 are carried by one or more inspectors. The handheld computers 112, 114 and 116 are connected to a dialup network 120. The data transfers can be performed using this dial-up network or directly from local area network at the main office. Specifically, the dialup network can simply be the Plain Old Telephone Service (POTS) network.

[0035] The dialup network 120 in turn is connected to a server 130 which is protected by a firewall. The firewall is a security system (hardware and/or software) that isolates resources of a computer system or network from objects outside of the system or network. Generally, the firewall allows for inside objects to request and receive connections to outside objects (e.g. for inside applications to access outside Internet sites, among others), but prevents outside applications from accessing resources inside the system or network.

[0036] Some firewalls permit only email traffic through them, thereby protecting the network against any attacks other than attacks against the Email service. Other firewalls provide less strict protections, and block services that are known to be problems. Generally, firewalls are configured to protect against unauthenticated interactive logins from the "outside" world. This, more than anything, helps prevent vandals from logging into machines on the user's network. More elaborate firewalls block traffic from the outside to the inside, but permit users on the inside to communicate freely with the outside.

[0037] The server 130 is connected to one or more contract databases 132, 134, 136, and 138. The server 130 also is connected to a master server 140. The master server 140 is connected to one or more master databases 142, 144, and 146. The master server 140 is also connected to one or more workstations, including a project manager workstation 150, a project engineering workstation 152, and an estimator workstation 154.

[0038] In this implementation, the master server 140 can be a plurality of redundant, fail-over servers, where each server can provide resources independent of the other until one of the servers fails. Each server continuously monitors the other server. In one implementation, server processes available from Microsoft Corp. of Redmond, Wash. called Microsoft Cluster Server (MSCS) uses a hot-standby technique in which a primary server and a standby server send "keep alive" messages back and forth so that the standby server is activated if it cannot contact the primary server. When one of the servers fails, the surviving server acquires the shared drives and volumes of the failed server and mounts the volumes contained on the shared drives. Applications that use the shared drives can also be started on the surviving server after the failover. Further, a manual-failover

operation can
be performed on the shared volumes at any time in order to perform tasks such
as scheduled maintenance on one of the servers. As soon as the failed server
is booted up and the communication between servers indicates that the server is
ready to own its shared drives, the servers automatically start the recovery
process.

[0039] The databases 142-146 can reside on one or more network RAID data
storage devices. In such an embodiment, the network RAID data storage device
is a collection of disks under hardware or software control so that a single
drive failure does not bring the system of FIG. 1 down. The data storage
devices may be a RAID-1 system, in which every disk has a mirror image of its
data stored on another disk. Alternatively, the data storage devices may be a
RAID-2 or RAID-3 sub-system which stripes user data across a group of data
drives (typically four or eight drives per group). The data storage devices
may also be a RAID-4 or RAID-5 sub-system which stripes block (or sometimes
groups of blocks) of data and stores the data entirely on an individual disk.

[0040] Referring now to FIG. 3, major modules associated with the system of
FIG. 2 is shown. In FIG. 3, a field journal 162 is maintained on an inspector
handheld computer 164. The inspector handheld computer 164 communicates with a
firewall server 166. The firewall server 166 in turn communicates with a main
server 170.

[0041] A plurality of modules are in turn are executed on the main server 170.
The modules include a new project module 171, a project information module 172,
a new contract module 173, a closure module 174 and a search module 175. The
new project module 171 creates and initializes database structures for a new

project. The project information module 172 provides management and accounting reports associated with a particular project. The new contract module 173 creates and initializes database structures for a new contract. The search module 175 searches for information relating a particular project or contract. The closure module 174 generates various final inspection reports and authorization for final payments. Additionally, the main server 170 executes a key indicator status (KIS) summary status module 176 that tracks the projects in terms of overall dollars and schedule time and provides at a quick glance whether each project is ahead of schedule or over/under budget.

[0042] Various reporting modules are also executed on a server 170. These modules include, but are not limited to, a daily report module 167, a monthly report module 168, and an estimate report module 169. Additionally, a change order module 177 performs the document management involved in sending out requests for information and eventually the change orders on a contract.

[0043] Referring now to FIG. 4, processes executed on the handheld computer 164 of FIG. 3 are shown. In FIG. 4, a plurality of inspector handheld computers 182, 184, and 186 communicate with a telephone company terminal 188. The terminal 188 can communicate over the POTS network. The terminal 188 is connected to one or more modems 190, 192, and 194. The modems 192 and 194 in turn transfer information to a dialup server 200 which contains a project database. The dialup server 200 communicates with a database administrator workstation 202, which allows a database administrator to maintain and operate the various databases. The dialup server 200 also communicates through a network connection to a main project server 210 which contains a planning design and construction project database. The server 210 also contains an

archival database for all closed projects. The main project server 210 also communicates with a project manager workstation 212 and an engineering/estimator workstation 214. The main project server 210 also communicates with a web site administrator workstation 216 which allows an administrator to manage the web site. The main project server 210 also communicates through the network connection to a web server 220. The web server 220 contains one or more project specific web sites so that the sites can be publicly accessed using the Internet. The web server 220 and the project-specific web site can host the reports generated from the Integrated Construction Project Management System (ICPMS) by saving to a specific folder related to each individual project. The project specific web site can be secured so that only people associated with the project can see reports from the web site.

[0044] The daily projects database contains folders with database files associated with a particular project. After initializing the construction database and performing a new project set up, a resident engineer or a field inspector posts daily reports or daily field journals which track on a daily basis the progress of the work. Each day, the inspector downloads a subset of the master database from the contract database that would only include the project information related to the projects being reviewed that day. At the end of the day, each inspector updates information for his reviewed project(s) and uploads or transmits that information back to the daily project folders in the contract database.

[0045] A field inspector can select the projects that he or she is interested in uploading and downloading. The uploading/downloading processes populate databases on the firewall server. A project estimator initially sets

up a
project folder. If a new project is uploaded to a folder on the firewall
server network, a unique project folder is created on the dialup server with
the following naming convention: a file folder name that correlates to the
project number and an assigned contract number and uploads project data into
the project folder. If the project already exists, the system simply copies
the project data into a new project folder on the server network.

[0046] Subsequently, the inspector sets up a dialup connection, logs-in with
the appropriate authorization, and invokes an upload/download menu. The
inspector selects a new project that's on the list and downloads information
associated with the selected project to his laptop or handheld computer. The
information includes data on costs, schedules, bid items, and change orders,
among others. Once downloaded, the inspector can update the bid item
quantities delivered and field progress information for the project. At the
end of the day, the inspector runs a daily field report--daily field journal
which includes information on the work performed for that day. The report can
also cover a range of days, so that if the inspector has been out on a job all
week and has been filling out daily field journals every day, a range of days
can be selected for transmission once.

[0047] After the firewall server has been updated, the estimator can repopulate
the master database to make it current. The estimator connects to this
firewall server and selects one or more projects to refresh the master
database. The updating the master database is done with a SQL command which
keys off of the project number and the contract as the primary keys.

[0048] Pseudo-code for the synchronization of project information between the
inspector's computer and the server is as follows:

[0049] Steps done by the Estimator/DB Administrator

[0050] Enters New Project Information into the Master Database

[0051] Activates the Upload/Download Menu

[0052] Selects the New Project just created

[0053] Selects the Send Button

[0054] This Creates a unique project folder on the Dial Up Server with the following naming convention: Project #+Contract #. This populates this folder with a database file containing only that projects information. The project is ready for the inspector to Hot Sync to his or her laptop or alternatively to his or her handheld computer. Pseudo code for steps done by the Inspector for a laptop hotsync is as follows:

[0055] Activate the Dial-Up Network Connection to the Fire Wall Server

[0056] Activates the Upload/Download Menu

[0057] Select the New Project from a pull down list

[0058] Select the Receive Button to hot sync the laptop computer

[0059] This downloads the project specific database created by the estimator.
The inspector creates is Daily Field Journal for that day

[0060] Activates the Upload/Download Menu

[0061] Select the Project from a pull down list and the day or range of days for the field journals to upload

[0062] Select the Send Button

[0063] This uploads only the information that change for that day or range of days selected to the Dial-Up Server

[0064] This completes the hot sync process by the inspector using a laptop computer.

[0065] If the inspector uses Pseudo code for steps done by the Inspector for a laptop hotsync is as follows:

[0066] Activate landline or wireless modem connection to a firewall server

[0067] Use the hot sync process to download project specific data based on an assigned project to the inspector handheld computer

[0068] The inspector or technician completes daily field journal forms or inspector testing form

[0069] Repeat until all project data has been processed

[0070] Steps done by the Estimator/DB Administrator are discussed in the next pseudo-code:

[0071] The Estimator now updates the master database with the current project information

[0072] Activates the Upload/Download Menu

[0073] Selects a Project or Multiple Projects for that day or range of days to update the master database

[0074] Selects the Receive Button to hot sync the master database

[0075] Once the daily project folders have been updated, an administrator of the database takes each project and uploads the folders to the master database that includes information for all the projects. Once data has been collected, a variety of reports can be generated, including a periodic report such as a monthly report, a progress report, a payment report, an estimate report relating to various aspects of contractor payments. Thus, project managers and administrators can have timely access to information for all projects. Old projects are moved to an archive projects database, which stores static data

that is not actively accessed. Data stored in the archive can be imported back into the database for review if needed.

[0076] FIG. 5 shows a planning/design/construction process. First, a new project is started (step 402). Next, various user privileges are assigned (step 404) and planning data is entered (step 406) into a planning projects database 408. The information stored in the project database can be can be used to generate a capital improvement plan (step 410) and can be exported into a web-accessible format (step 412) and placed on a project-specific web site (step 414).

[0077] Additionally, the information stored on the planning project database can be exported (step 420) as a project information to a design projects database 426. The design projects database can receive contract information (step 422) as well as design information(step 424). The design project database can generate a design status report (step 428) which can be exported to the web format (step 412) for placement on the project specific website (step 414). Additionally, information from the design project database can be provided to a schedule data interface (step 430) that provides output compatible to one or more project schedulers such as Microsoft Project, among others (step 432). Further, the output from the design project database can be provided to a bid package information module (step 434), which in turn can be used in a spreadsheet for contractors to submit cost values on the contract bid items (step 436). This data can be imported (step 438) and analyzed (step 440) and provided to a winning bid export file (step 442). The winning bid output can then be provided to a master construction projects database 450. The master construction projects database can also directly receive project information from the design projects database (step 448).

[0078] The master construction projects database 450 can receive contract data (step 452), project data (step 454), and can also send and receive information (step 456) from a daily activity database 460. The daily activity database 460 handles field project information (step 462) as well as daily field journal information (step 464). The output of the master construction database 450 can also be archived as an archive project information module (step 47-) in a closed projects database 480.

[0079] Referring now to FIG. 6, the planning system 102 is shown in more detail. The planning system 102 manages the long term planning for program management of budgets, funding, and schedules. This long term planning information is the core information used in municipalities and agencies Capital Improvement Plans (CIPs). The planning system 102 includes a module for handling capital improvement plan 232 that can be used to provide decision support for municipalities. For example, a owner or agency can have a five-year capital improvement plan. The owner or agency can categorize different elements in that plan. For example, one may be involved with the parks and recreation program, one may be involved with the fire program, and one may be involved with the street and bridge program.

[0080] The capital improvement plan module 232 communicates with a plurality of program modules 234, 238, and 242. Further, the program module 234 stores information 236 associated with the first project. Similarly, the program module 238 stores information 240 associated with the second project, and module 242 stores information 244 associated with the Nth project. This structure allows for summary roll-up reports at he project, program, and CIP level.

[0081] The planning system 102 includes a Fund/Source Module that maintains multi-year budget plans for the overall CIP process. This allows program managers to create a multi-year Capital Improvement Plans and track the funding sources by program, fund, and by source. Each CIP plan is controlled separately to maintain a historical record of the previous year's CIP plan. This Planning System controls and manages the data associated with this process.

[0082] The Design System manages the document control process for design process. This system contains various modules that provide the PCS functions from Design Contract Award to Construction Contract Award. The following are the modules and the sections below will describe how each Design System module controls the design information by performing documentation control of design information for each individual their projects:

[0083] Design Contract Award Phase Module

[0084] Design Phase I Module

[0085] Design Phase II Module

[0086] Design Review Module

[0087] Post Advertisement to Bid Phase Module

[0088] Post Bid to Construction Contract Award Module

[0089] Phase I spans the time where a user has awarded a contract to a particular design or architectural firm to preliminarily design the project. Phase II spans the time required to perform a complete design where construction details are defined. For instance, if the user is building a building, the Phase I design includes performing a site layout. Phase II Design would be what the user wants an atrium area to look like inside, for example. Phase II would also then specify all the structural

details, for
example the cabinets and the doors, and the result of Phase II a very detailed
design specification.

[0090] The software is customizable to the individual user by developing
templates that resemble a client's existing forms. These modules are all
follow the software design architecture and allow the user to select a forms
from a dialog box list. This launches the appropriate input window to appear
so the user can view and update the design information as required.

[0091] Referring now to FIGS. 7a, 7b and 7c, operations associated with the
design module 104 is shown. In FIG. 7a, a meeting is initiated (step 250).
Next, interim progress reviews are periodically performed, for example, every
two to three weeks (step 250). Next, conflicts between the private utility and
various governmental agencies are coordinated (step 254). In step 256, various
investigations are performed. This investigations include geotechnical
investigations, environmental assessments, survey activities and archeological
investigations. Next, the process of FIG. 7a analyzes the real estate
activities associated with the design. These activities include railroad right
of way and private pipeline permits (step 256). Next, a preliminary
engineering report is drafted (step 260). A schematic design is submitted
(step 262). A pretechnical review is performed (step 264-266). The decisions
and action items of the technical review are captured (step 268), and a
preliminary engineering report is finalized (step 270).

[0092] From step 270, a schematic design is generated and submitted for the
architectural project (step 278). Next, another pretechnical review meeting is
held (step 280-282). The records of the decisions and action items associated
with a technical review committee meeting are stored (step 284). A preliminary

engineering report is then generated (step 286). The design development submittal is then sent (step 288). The scope of the final design is refined (step 290). Finally, the project receives a notice to proceed (step 292) before the phase one of the design is deemed to be completed (step 294).

[0093] Phase I Design Module manages the documentation associated with the following fifteen (15) phases of this process. The flowchart on the following page illustrates the Phase I Design process.

[0094] 1. Kick-Off Meeting

[0095] a. Estimate for Payment

[0096] b. Design Consultant Memorandum--Action Item Completion

[0097] 2. Interim Progress Review Meetings

[0098] a. Design Consultant Memorandum--Action Item Completion

[0099] 3. Private Utility and Other Agency Conflict Resolution

[0100] a. Documents in this phase are generated by Design Consultant (DC) this phase is mainly to resolve any private utilities conflicts which could be potential construction conflicts

[0101] 4. Geotechnical Investigation

[0102] a. Authorization to Initiate Geotechnical Investigation

[0103] b. Geotechnical Report

[0104] 5. Environmental Site Assessment

[0105] a. Authorization to Initiate Phase I Environmental Site Assessment

[0106] b. Phase IA ESA Report

[0107] 6. Survey Activities

[0108] a. Authorization to Initiate Survey Work

[0109] 7. Real Estate Activities

[0110] a. Authorization to Initiate Real Estate Activities

[0111] b. Real Estate Information Package

[0112] 8. Archeological Investigation

[0113] a. Document reference location information only

[0114] 9. Other Additional Services

[0115] a. Authorization to Initiate Additional Service

[0116] 10. Preliminary Engineering Report (Draft)

[0117] a. Document reference location information only

[0118] 11. Pre-Technical Review Committee (TRC) Meeting

[0119] a. Document reference location information only

[0120] 12. Technical Review Committee (TRC) Meeting

[0121] a. Technical Review Committee Meeting Announcement

[0122] b. Technical Review Committee Meeting Agenda

[0123] c. Technical Review Committee Meeting Project Summary

[0124] d. Record of Decisions and Action Items from TRC Meeting

[0125] 13. Preliminary Engineering Report (Final)

[0126] a. Document reference location information only

[0127] 14. Contract Amendment or Supplemental Appropriation

[0128] a. Professional Scope of Service/Fee

[0129] b. If changes accepted than appropriate steps need to be followed for
Authorization

[0130] c. Package, Contract and Ordinance, and Award and Execution of Design
Consultant Contract

[0131] 15. Notice to Proceed (NTP) for Phase II Design

[0132] Referring now to FIG. 7c, Phase II of the design process is shown.
First, a meeting is kicked off (step 270). Next, interim submittals are
generated (step 274). The interim progress review meetings are held to review
the interim submittals (step 276). Next, various investigations are performed
(step 278). These investigations include geotechnical investigations,
environmental site assessments, server activities, railroad activities and/or
archeological investigations.

[0133] From step 278, additional operations are performed (step 280). The
final design submittal is generated (step 282) and finalized contract documents
are generated (step 284) before the Phase II design is completed (step 286).

[0134] Phase II Design module manages the documentation associated with the
following eleven (11) phases of this process. The flowchart on the following
page illustrates the Phase II Design process.

[0135] 1. Kick-Off Meeting

[0136] a. Record of Decision and Action Items (RDAI)--Action Item Completion

[0137] 2. Interim Progress Review Meetings

[0138] a. Record of Decision and Action Items (RDAI)--Action Item Completion

[0139] 3. Interim Milestone Submittals

[0140] a. Document reference location information only

[0141] 4. Private Utility and Other Agency Conflict Resolution

[0142] a. Design Consultant Internal Activities

[0143] 5. Additional Geotechnical Investigation

[0144] a. Authorization to Initiate Additional Geotechnical Investigation

[0145] 6. Phase II Environmental Site Assessment (ESA)

[0146] a. Authorization to Initiate Phase II Environmental Site Assessment

[0147] 7. Survey Activities

[0148] a. Authorization to Initiate Survey Activities

[0149] 8. Real Estate Activities

[0150] a. Authorization to Initiate Real Estate Activities

[0151] 9. Additional Archeological Investigation

[0152] a. Authorization to initiate Additional Archeological Investigation

[0153] 10. Other Additional Services

[0154] a. Authorization to Initiate Other Additional Services

[0155] 11. Final Design Documents p2 a. Construction Drawings, Completed
Project Manual, Estimate of Construction Cost, Geotechnical Report, Final
Engineering Design Report, Completeness Checklist

[0156] Phase II Design Review Module manages the documentation associated with
the following eleven (11) phases of this process. The flowchart on the
following page illustrates the Final Design Review process.

[0157] 1. Contract Project Director (CPD) Plan Review

[0158] a. Document reference location information only--DC submits final design
plans to CPD and PM staff

[0159] 2. Owning Division/User Agency Review

[0160] a. No Documentation

[0161] 3. Constructability Review

[0162] a. No Documentation

[0163] 4. Front-End Documents

[0164] a. Form 00010--Project Information Form (C)

[0165] b. Document 00800--Supplementary Conditions guide (C)

[0166] c. Division 00--Bid Documents--refer to attached page of all bid
documents that need to be submitted

[0167] d. Division 01--General Requirements

[0168] e. The purpose of this phase is to develop a package which will consist
of Bid Documents, General Requirements, and basic correspondence for the
Project Manger to review

[0169] 5. Bid-Ready Documents

[0170] a. No documentation--documents from previous step are reviewed once more
and after review the front-end documents are placed into construction documents

[0171] 6. Code Enforcement Review for Building Permit (if required)

[0172] a. Commercial Building Permit Application

[0173] 7. Private Utility Signatures and Other Agency Approvals (if required)

[0174] a. No documentation

[0175] 8. Authorizing Signatures

[0176] a. No documentation--purpose is for all bid-ready documents for project
to be approved by owner or agency

[0177] 9. Request for Advertisement

[0178] a. Advertisement for Bids

[0179] b. Request for Advertisement

[0180] 10. Production of Bid-Ready Documents

[0181] a. Plan Holder's List

[0182] 11. Advertisement for Bids

[0183] a. No documentation--purpose is to advertise in the newspaper for bids

[0184] Referring now to FIG. 8, various modules associated with the construction system 106 are shown. First, the help module 108 is provided.
Next, a new project launch 110 receives new projects being opened. The new
project module is the first module that needs to have user input before any
other module will function. This module will consist of the project information table. The new project will have an input field for project name
and project number. The project number is critical since the database will key
of this number to link other related data tables. Other input fields that will
be needed for this module are funding number, funding source, drawing number,
key map number, area, and council district. The primary data table that the
new project table will be interfacing with is the contract information data
table.

[0185] The new project module 110 communicates with a new contract module 112.
The new contract module will define the contract information for the project.
The module will consist of a contract information data table, contractor
information data table, contractor affidavit data table. This module will
receive project data from the new project information table. The new contract
module will have an input field for the contractor number and contractor name,
which will be the primary fields. The contract information will also consist
of the unit bid contract, which will define the unit price for each item needed
for the project along with its planned quantity. The other input fields will
consist of contractor id, contract date, contract amount, contract days,
ordinance number, gfs number, contractor name, and contract start date.

[0186] The new contracts module 112 in turn communicates with a bid price

module 114. The Unit Price Bid Contract Module imports the winning construction contractor bid tabulation information. This Bid Tab will be used in by inspectors to track the actual quantities delivered and computation of the contractors earned value will be performed.

[0187] The unit bid price module 114 communicates with a daily field report module 118. This is an output module that will create the daily posting report. This module will be linked and take input from the three data tables described in the Field Journal Module. The major items that will be queried from the data tables and presented in the daily posting report are the item number, location of where the work is being done, description of the type of work, the actual quantity of that item used for that day, a cumulative total of the quantity used for that month including that day, the total quantity used for the entire project including that day, the percentage complete and unit price. The formula required to calculate the cumulative total of quantity utilized for the month is shown in equation 1. and the calculation used to determine the total quantity used for the project is shown in equation 2.
Equation 3 shows the formula needed to calculate the percentage work complete.

Quantity_Actual=Quantity of Item per day (Equation 1)

Cumul_QTY=.SIGMA.(Quantity_Actual's) (Equation 2)

% Work Compete=(Plan_QTY--Cumul_QTY)/Plan_QTY (Equation 3)

[0188] A print function will be needed in this module to print out the daily posting report in MS Word format in which the necessary data will be inputted into a defined template.

[0189] In addition, a daily field journal 116 communicates with the daily field reports module 118. This module will consist of four data tables, which are

the daily work progress table, daily equipment table, daily labor force table
and submittal table. The user-input fields for the daily work progress table
will include the project number, contract number, report date, item number, and
actual quantity. The input fields for the daily equipment table will consist
of equipment quantity, hours in use, standby hours, site location, and work
type. The input fields for the labor will contain manpower, hours and work
type. The submittal table will consist of the submitters' names and the
weather for that day. All four data tables will be linked using the project
number and contract number. This module can be run as a standalone module by
the inspector's laptop to connect to a dial-up server. Once the dial-up server
connection is established, the send/receive menu allows for uploads and
downloads of selected projects.

[0190] The daily field reports module 118 can communicate with a monthly
estimate report module 122. This module is also an output module that will
basically combined the totals from the daily field reports for each month at
the project cutoff date and print a report. The report will consist of each
item for the project along with its unit, planned quantity for the entire
project, quantity used for the month and quantity used for the entire project
through the cutoff date. These items will queried from the daily field report
tables monthly. The report will also contain the unit price, total amount
spent for each item and cumulative total for all items. The unit price
information is defined in the new contract information table and this table
will be linked to that table using the contract and project number. The
equation to determine the total amount spent on each item to date and
cumulative totals are depicted in equation 4 and 5 respectively.

Item Total Amount to Date=.SIGMA.(Quanity_Actual)*Unit Price

(Equation 4)

Item Cumulative Totals=Cumul_QTY*Unit Price (Equation 5)

[0191] A print function will be needed in this module to print out the daily posting report in MS Word format in which the necessary data will be inputted into a defined template.

[0192] The monthly estimate report module 122 in turn communicates with a document closure module 130. This module function is to develop all the closure documents that are required for project completion. Individual templates will be created for each document. The appropriate tables for each document will queried to fill out each template. The templates will be created in MS Word format. The closure document templates that will need to be created are listed below.

[0193] Final Payment Certificate

[0194] Change Orders

[0195] Consent of Surety Letter from Contractor

[0196] Contractors Certificate of Final Completion

[0197] Copy of Approved Council Motion

[0198] Affidavit of Work Performed

[0199] Each user of the software package will have their own user-defined documents or forms. These documents are user configurable by updating or adding new templates can be created using MS Word depending on the company's requirements without requiring a software source code change.

[0200] The daily field reports modules 118 can communicate with a change order module 120 in the event changes are required. If so, the change order module 120 communicates with the unit bit price 114 and the new contract module 112.

The requirements for this module are to allow changes to be made to the initial contract. The module will be linked to the new contract table and allow the user to make a change to the original contract. A change order has to go through certain before it is approved. This module will generate the proper documents needed for the change order such as the request for information (RFI), request for proposal (RFP), and the actual change order document. The change order tables will be linked by contract number to extract the appropriate contract information needed for the forms. The change order table will also need to be linked to previous change order (CO) tables to allow the user to know what previous changes have been made to the contract. The fields that will be inputted into the change order tables are the amount and duration of the current change order along with the date that the change order is submitted. This module will then calculate the total amounts of the previous change orders based on equation 6 and previous time extensions based on equation 8. Further, the module will also calculate the revised contract price and revised schedule using equations 7 and 9.

APCO=.SIGMA.(Previous Contract Change Orders) (Equation 6)

Revised Contract Price=Original Contract Price+APCO+Current CO Amount (Equation 7)

PTE=.SIGMA.(Previous Time Extensions) (Equation 8)

Revised Schedule=Original Contract Duration+PTE+Current CO Extension (Equation 9)

[0201] In addition, a search module 109 is provided to assist users in locating documents when necessary.

[0202] The main function of this module is to determine the project status based on the project's key indicators. This module is for output

there will be
no inputs. This module will be linked to the project information table,
contract information table, and the estimate tables for each project. This
module will query the latest information from these tables to determine if the
project is ahead of time, on time, or behind. This will done by looking at the
percentage of work completed against actual days used to complete the work
using equation 10.

% WKComp=.SIGMA.(Item Cumulative Totals)/Revised Contract Price*100 (Equation
10)

[0203] This module will create an summary output table which will include the
project name, gfs number, contract name, contract number, contractor, contract
date, contract amount, contract days, work complete, number of days used,
amount paid, percent of total amount paid (equation 11), and lagging indicator
(Equation 12).

% By Time=Days Used/Revised Schedule*100 (Equation 11)

% Lagging=% WKComp-% By Time (Equation 12)

[0204] The main function of this Schedule Module module is to track the
schedule for each bid tabulation item. The user interface controls the start
and finish dated for each item. This module provides an interface to MS
Project.TM. that automatically launches, transmits the item description, start
date, and finish date to display the project schedule.

[0205] The main function of this Send/Receive Data Module module is to control
the Daily Field Journal data from the Master Database. This module allows the
inspectors using Inspect-IT and the estimators using Construct-IT to manage
these Daily Field Journal Updates. Before activating the Send/Receive Data
Module, the user will need to dial-up or connect to the project

database
server. The user selects the project and the date for which these updates are
to be performed, and select the appropriate Send or Receive button for the
transition required.

[0206] The main function of this module is to control user access and update
privileges to the content of the Master Database. This module assumes four (4)
user types: Inspector, Estimator, Project Manager, and Database Administrator.
In addition, this module allows the Database Administrator to configure the
users privileges based on a project by project and department by department
basis. In general, the Database Administrator would configure the system to
allow the following privileges:

[0207] Inspector: Daily Field Journal (Read/Write)

[0208] Estimator: Daily Field Journal (Read)+Monthly Estimate Report Module
(Read/Write)

[0209] Project Manager: Main Modules (Read/Write/Update)

[0210] Database Administrator: (Full Control)

[0211] There will be a help button in the main window. The help with give a
complete overview of how the program works and how all the modules are
interrelated. Moreover, the help will consist of descriptions of the different
functions of the software package. The help will also give a description of
each button and its purpose. In addition to the help button that appears in
the main window, help on the individual modules will be available. The help on
the individual modules will describe the input fields for each module along
with the function and use of the module.

[0212] A search function will allow the user to search for a particular item in
the database. The search will consist of selecting a project or

contract and
then searching for a particular item associated with that particular contract
or project. The search will have to be linked to both the project and contract
tables through their project number and contract number to allow the user to
find a particular data item in the database.

[0213] FIG. 9 illustrates an exemplary handheld computer system for collecting
and managing construction data. The computer system is preferably housed in a
small, rectangular handheld enclosure. Referring now to FIG. 9, a general
purpose architecture for entering information into the data management by
writing or speaking to the computer system is illustrated. In FIG. 9, a
processor 20 or central processing unit (CPU) provides the processing
capability for the sketching system of the present invention. The processor 20
can be a reduced instruction set computer (RISC) processor or a complex
instruction set computer (CISC) processor. Preferably, the processor 20 is a
low power CPU such as the MC68328V DragonBall device available from Motorola
Inc.

[0214] The processor 20 is connected to a read-only-memory (ROM) 21 for
receiving executable instructions as well as certain predefined data and
variables. The processor 20 is also connected to a random access memory (RAM)
22 for storing various run-time variables and data arrays, among others. The
RAM 22 is sufficient to store user application programs and data. In this
instance, the RAM 22 can be provided with a back-up battery to prevent the loss
of data even when the computer system is turned off. However, it is generally
desirable to have some type of long term storage such as a commercially
available miniature hard disk drive, or non-volatile memory such as a
programmable ROM such as an electrically erasable programmable ROM, a flash ROM
memory in addition to the ROM 21 for data back-up purposes. The RAM

22 stores
a database of the spreadsheet of the present invention, among others.

[0215] The computer system 10 of the present invention has built-in applications stored in the ROM 21 or downloadable to the RAM 22 which include,
among others, an appointment book to keep track of meetings and to-do lists, a
phone book to store phone numbers and other contact information, a notepad for
simple word processing applications, a world time clock which shows time around
the world and city locations on a map, a database for storing user specific
data, a stopwatch with an alarm clock and a countdown timer, a calculator for
basic computations and financial computations, and a database for storing
collected construction data. Additionally, project planning tools, and CAD/CAM
systems, Internet browsers, among others, may be added to increase the
functionality of handheld computing appliances. Users benefit from the
software, as the software allow users to be more productive when they travel as
well as when they are in their offices.

[0216] The computer system of the present invention receives instructions from
the user using one or more switches such as push-button switches in a keypad
24. The processor 20 is also connected to a real-time clock/timer 25 which
tracks time. The clock/timer 25 can be a dedicated integrated circuit for
tracking the real-time clock data, or alternatively, the clock/timer 25 can be
a software clock where time is tracked based on the clock signal clocking the
processor 20. In the event that the clock/timer 25 is software-based, it is
preferred that the software clock/timer be interrupt driven to minimize the CPU
loading. However, even an interrupt-driven software clock/timer 25 requires
certain CPU overhead in tracking time. Thus, the real-time clock/timer
integrated circuit 25 is preferable where high processing performance is

needed.

[0217] Additionally, the expansion bus 26 can receive a wireless transceiver 31, which is connected to an antenna 32. The wireless communication device 31 satisfies the need to access electronic mail, paging, mode/facsimile, remote access to home computers and the Internet. One simple form of wireless communication device 31 is an analog cellular telephone link where the user simply accesses a cellular channel similar to the making of a regular voice call. However, the transmission of digital data over an analog cellular telephone network can give rise to data corruption. Digital wireless networks such as cellular digital packet data (CDPD) can be used. CDPD provides data services on a non-interfering basis with existing analog cellular telephone services. In addition to CDPD, a communication service called Personal Communication Services (PCS) allows wireless access into the public service telephone network.

[0218] The two-way communication device 31 can also be a two-way pager where the user can receive as well as transmit messages. The two-way communication device supports a Telocator Data Protocol by the Personal Communications Association for forwarding binary data to mobile computers. The standard facilitates transmission of images and faxes over paging and narrowband PCS networks. Alternatively, the two-way communication device 31 can be substituted with a cellular telephone.

[0219] The two-way communication device 31 has a receiver, a transmitter, and a switch, all are controlled by the CPU 20 via the bus of the handheld computer system of FIG. 1. The switch receives an input from the antenna 32 and appropriately routes the radio signal from the transmitter to the antenna 32, or alternatively, the radio signal from the antenna 32 to the

receiver in the event the processor 20 is expecting a message. Via the bus 26, the processor 20 controls the receiver, the transmitter, and the switch to coordinate the transmission and receipt of data packets. The receiver and transmitter are standard two-way paging devices or standard handheld cellular communication chips available from Motorola, Inc. in Schaumburg, Ill. or Philips Semiconductors in Sunnyvale, Calif. The antenna 32 is preferably a loop antenna using flat-strip conductors such as printed circuit board wiring traces as flat strip conductors have lower skin effect loss in the rectangular conductor than that of antennas with round-wire conductors.

[0220] The processor 20 of the preferred embodiment accepts handwritings as an input medium from the user. A digitizer 34, a pen 33, and a display LCD panel 35 are provided to capture the handwriting. Preferably, the digitizer 34 has a character input region and a numeral input region which are adapted to capture the user's handwritings on words and numbers, respectively. The LCD panel 35 has a viewing screen exposed along one of the planar sides of the enclosure are provided. The assembly combination of the digitizer 34, the pen 33 and the LCD panel 35 serves as an input/output device. When operating as an output device, the screen 35 displays computer-generated images developed by the CPU 20. The LCD panel 35 also provides visual feedback to the user when one or more application software execute. When operating as an input device, the digitizer 34 senses the position of the tip of the stylus or pen 33 on the viewing screen 35 and provides this information to the computer's processor 20. In addition to the vector information, the present invention contemplates that display assemblies capable of sensing the pressure of the stylus on the screen can be used to provide further information to the CPU 20.

[0221] The preferred embodiment accepts pen strokes from the user using the stylus or pen 33 which is positioned over the digitizer 34. As the user "writes," the position of the pen 33 is sensed by the digitizer 34 via an electromagnetic field as the user writes information to the data management computer system. The digitizer 34 converts the position information to graphic data that are transferred to a graphic processing software of the data logger computer system. The data entry/display assembly of pen-based computer systems permits the user to operate the data logging computer system as an electronic notepad. For example, graphical images can be input into the pen-based computer by merely moving the stylus over the surface of the screen. As the CPU 20 senses the position and movement of the stylus, it generates a corresponding image on the screen to create the illusion that the pen or stylus is drawing the image directly upon the screen. The data on the position and movement of the stylus is also provided to a handwriting recognition software, which is stored in the ROM 21 and/or the RAM 22. The handwriting recognizer suitably converts the written instructions from the user into text data suitable for saving time and expense information. The process of converting the pen strokes into equivalent characters and/or drawing vectors using the handwriting recognizer is described below.

[0222] Preferably, the handwriting recognizer of the present invention recognizes non-cursive characters in a fixed style using a basic character set, preferably a 36-character alphanumeric character set. In addition to the basic 26 letters and 10 digits, the non-cursive handwriting recognizer includes multi-step pen strokes that can be used for punctuation, diacritical marks, and capitalization. Preferably, the non-cursive handwriting recognizer is a software module called GRAFFITI, commercially available from Palm

Computing,
Inc. Each letter in the non-cursive alphabet is a streamlined version of the
standard block character--the letter A, for example, looks like a pointy
croquet hoop, and the hoop must be started at the dot indicator at the lower
right corner-- as illustrated and discussed in more detail in the above
incorporated-by-reference U.S. patent applications. By restricting the way
the user writes, the non-cursive handwriting recognizer achieves a more perfect
recognition and, as with stenography, supports an alphabet consisting of
characters that can be written much more quickly than conventional ones.

[0223] The computer system is also connected to one or more input/output (I/O)
ports 42 which allows the CPU 20 to communicate with other computers. Each of
the I/O ports 42 may be a parallel port, a serial port, or alternatively a
proprietary port to enable the computer system to dock with the host computer.
In the event that the I/O port 42 is housed in a docking port 84, after
docking, the I/O ports 42 and software located on a host computer 82 support an
automatic synchronization of data between the computer system and the host
computer. During operation, the synchronization software runs in the
background mode on the host computer 82 and listens for a synchronization
request or command from the computer system 10 of the present invention.
Changes made on the computer system and the host computer will be reflected on
both systems after synchronization. Preferably, the synchronization software
only synchronizes the portions of the files that have been modified to reduce
the updating times.

[0224] The I/O port 42 is preferably a high speed serial port such as an RS-232
port, a Universal Serial Bus, or a Fibre Channel for cost reasons, but can also
be a parallel port for higher data transfer rate. Preferably, the

I/O port 42
has a housing which is adapted to snappably connect to the housing of a Musical
Instrument Digital Interface (MIDI) player 37, a fax modem 40, a voice recorder
43, a GPS receiver 46 and a barcode reader 48. When the I/O port 42 is
connects to the MIDI player 37, the computer system 10 drives high quality
audio speakers 38 and 39 which connect to the MIDI player 37 to support
multimedia applications on the computer 10.

[0225] Additionally, via the serial port 42, a fax-modem 40 is adapted to
receive information over a telephone 41 via a plain old telephone system (POTS)
landline or over the radio frequencies and allow the user to access information
untethered. Further, the modem 40 may serve as part of a wide-area-network to
allow the user to access additional information. The fax-modem 40 can receive
drawings and text annotations from the user and send the information over a
transmission medium such as the telephone network or the wireless network to
transmit the drawings/text to another modem or facsimile receiver, allowing the
user to transmit information to the remote site on demand. The fax-modem 40
can be implemented in hardware or in software with a few additional components
such as a DAA, as is known in the art.

[0226] The case is a rectangular plastic casing with a major opening on the top
of the case to receive the LCD panel 35 and the digitizer 34. The case has a
receptacle which is adapted to receive and store the pen 33. Furthermore, a
plurality of push-buttons in the keypad 24 are positioned on the top side of
the case. The push-buttons of the keypad 24 preferably allows the user to
invoke one or more pre-installed software on the handheld computer.
Additionally, the case has an opening on the backside which is adapted to
receive a connector carrying the electrical impulses to and from the I/O port

42.

[0227] The handheld computer executes software stored in an excutable format
such as a prc file. The software allows the handheld computer to track Daily
Field Journals, such as:

[0228] Work Progress of Unit Bid Items and Contract Deliverables

[0229] Manpower Utilization

[0230] Equipment Utilization

[0231] General Information including weather, temperature, remarks, and
inspector's name.

[0232] The software also tracks an Inspection Checklist, such as:

[0233] Generation of Punch list items

[0234] Tracking of Punch list items

[0235] Facility Inventory

[0236] Facility Repairs & Cost Estimates

[0237] The software also keeps Project Documentation and captures, among
others:

[0238] Project Specifications

[0239] Industry Specifications

[0240] Drawing Logs

[0241] FIG. 10 shows an exemplary process 500 for collecting data in the field
and uploading the data to the computer of FIG. 1. First, a user collects work
in progress data (step 510). The information collected includes
project/contract identification, inspector identification, item number,
location, and one or more description of activities. Various exemplary screens
on a handheld computer for step 510 are shown as FIGS. 11-18. Next, the user
collects labor related cost (step 520). The information collected in

step 520
includes labor type, quantity and hours. Next, the process 500 collects
equipment being used for the project (step 530). The information collected
includes equipment type, quantity, hours in use and stand-by hours. Next, the
process 500 collects additional submittal information (step 540). The
information collected includes weather condition, comments, and the name of the
inspector, among others. The process 500 then sends the collected information
to the system of FIG. 1 (step 550). This can be done wirelessly using a
wireless handheld unit such as the Palm VII, available from Palm Computing.
Alternatively, the information can be transmitted using a modem or using an
external computer with a suitable hot-sync cradle. In the later case, the
handheld unit is synchronized with the external computer and, upon concluding
the synchronization, the external computer opens a connection with the server
of FIG. 1 and transmits the collected data from the handheld unit. The
collected information is then imported to the database of FIG. 1, and
appropriate data import operations and report generation operations can be done
(step 560). The process 500 then exits.

[0242] After collecting data, the handheld computer is placed in a hot sync
cradle or aligned with an infrared port on a host computer for data transfer.
The user, or inspector, activates a data receiving software on a workstation or
a laptop. The user selects an icon to initiate data uploads and downloads to
the handheld computer. The user will select the project to be updated or
refreshed before selecting the icon. Only changed project information will be
uploaded. The downloading of project information is performed the same way, a
project is selected and selection of the icon initiates the file transfer. The
file transfer results in the project information stored in a database to be

converted to a handheld format such as a "pdb format". The "pdb format" will result in an individual project table to be generated for each project on the handheld computer. Updates to the table is done in the same manner as described above.

[0243] FIG. 19 shows an exemplary process 600 to handle quality assurance to check one or more construction projects. The process 600 provides an interface for efficient operation and expedient problem resolution. First, a service request is generated (step 602). Based on the service request, a work order is generated (step 604). The work order is entered (step 606), and various forms such as daily project forms are filled with data (step 608).

[0244] Data collected includes work performed by subcontractors, and materials produced by fabricators, suppliers and vendors. The process also monitors the process control program to assure it is functioning and supports acceptance inspections and acceptance sampling and testing. Data collected can also include material data on Cement; Reinforcing Steel Epoxy; Reinforcing Steel; Precast, Prestressed Concrete Structures; Ready-Mix Concrete; Fly Ash and Pozzolan; Asphalt Emulsion; Asphalt Binder; Hydrated Lime; and Concrete Pumping. Further, the system collects acceptance testing data on manufactured materials such as aggregates, Hot Asphalt Mixes, and Portland Cement Concrete products. For other commercially fabricated materials, the system collects data on the Manufacturer's Certificate of Compliance.

[0245] Using a suitable field computer such as the handheld computer described above, the quality personnel performs full time surveillance during construction. In addition to daily inspection of the physical performance of the work, surveillance may include any combination of the following:

[0246] a) Observation of Process Control measures performed;

[0247] b) Review or spot checks of procedures or instructions governing the
work, including inspection and test procedures;

[0248] c) Evaluation or verification of the presence and effectiveness of
Project controls;

[0249] c) Discussion with personnel performing or supervising the work.

[0250] The results of the surveillance are documented in the Daily Inspection
Report and reported to a Segment Quality Engineer responsible for the activity

[0251] Completed items can be inspected for completeness, markings, calibration, adjustments, protection from damage, or other characteristics
required to verify the quality of workmanship and conformance of the item to
specified requirements

[0252] Quality records can be examined for adequacy and completeness and
available for audit.

[0253] Inspection and test results can be documented in accordance with the
quality plan.

[0254] Prior to final inspections and tests, a review of the deficiencies
identified during the acceptance inspections and tests can be performed to
verify that corrective action has been completed, verified and documented. The
final inspection or test can demonstrate the conformance of the item to
specified requirements.

[0255] After each daily data collection by quality field personnel, the data on
the handheld device is uploaded to the handheld device using a process known as
hot-syncing (step 610). When new data has been uploaded, the project manager
is notified (step 612). The manager reviews the daily project data collected

using the handheld device (step 614) and generates daily project reports (step 616). Additionally, a key indicator summary report is generated from consolidated daily project reports (step 618). The summary report and/or the daily project reports are posted on a web site (step 620).

[0256] The customer is notified after reports have been posted on the web site (step 622). The user can then go on-line and select a project specific web site using a browser, for example (step 624). Upon entering the project specific web site, the user enters his or her identification and password (step 626) and proceeds to view the daily project reports as well as the key indicator summary reports (step 628). Construction progress is updated monthly, by the status of the summaries. The process also provides daily acceptance information by work activity, consistent with the work schedule. The quality testing and acceptance data are identified by the same activity numbering system used in the construction schedule and invoicing process. Identifying work activities consistently between the work schedule, payment schedule and quality testing and inspection reports assures fair and reasonable progressing of the work. Work documented as deficient, or work not being performed in accordance with the contract is identified by the system for follow-up if necessary.

[0257] During use, the user provides various "released for construction" plans that have been through the quality review process to a builder and a work plan is developed. The builder performs the work by following good construction practices and process control procedures. A combination of process inspections, testing and surveillance is performed using the process 600 in a systematic manner to assure the specific requirements for control of the process and quality of the item are being achieved throughout the duration of

the process. Inspection and testing of items in process or under construction is performed for work activities as required in the quality plan to verify conformance to the requirements. Process control inspections and tests may be performed by the Process Control group, and inspections and tests include qualification tests, factory tests, installation and verification tests, material tests and pre-operational checks/tests. The source inspection of items fabricated or manufactured specifically for the Project will be performed jointly as required by the Contract Documents. Items furnished by suppliers to be incorporated into the Work, such as commercial items, bulk materials, subassemblies, and subcontractor/supplier furnished items, can be inspected upon receipt. Inspection/testing activities for purposes of acceptance shall be independent from those used for process control. Individuals performing the inspections/testing can be qualified and certified as necessary to perform the applicable task. The customer can review on-line to see if the process control processes have been followed as detailed in the quality plan. When an element of work has progressed to a point that it would be covered by the next element and would not be easily inspected or accessible, the builder can request an acceptance inspection. This would occur when the builder deems the work progress; including process control; has been completed and is ready for acceptance inspection and testing. Acceptance Inspections and Tests can be performed, and the results are evaluated to verify acceptability and conformance to the contract requirements. Acceptance will be based on conforming results. The process 600 supports inspection checks that include the following:

[0258] Identification of the individuals or groups responsible for performing the inspection or test, including material testing laboratory;

[0259] Items to be inspected;

[0260] Location of inspection/test (on/off site);

[0261] Identification of characteristics and activities to be inspected or
tested;

[0262] A description of the method of inspection or test;

[0263] Acceptance criteria;

[0264] Identification of procedures, drawings and specifications;

[0265] Frequency of the required inspections or tests

[0266] The process 600 supports a three (3)-phase inspection plan:

[0267] Phase 1--Preparatory Inspection Review

[0268] Prior to the start of work on an identified feature of work, the user
will review and become familiar with the released for construction plans. They
will participate in the pre-activity meetings. They will understand the
quality procedures, work plan and the requirements of the Contract Documents.
The purpose of the pre-activity meeting is to assure there is no
misunderstanding as regards to the quality, as well as safety and environmental
issues, material and equipment contemplated, testing requirements, acceptance
criteria, including workmanship and documentation to be submitted attesting the
achievement of the quality and technical requirements

[0269] Phase 2--Daily Inspection Reviews (Surveillance)

[0270] The quality Field Inspectors will review and monitor the work on the
Project on a daily basis using the process 600. They can communicate to the
customer any perceived conditions that could result in rework.

[0271] Phase 3--Acceptance Inspection and Testing

[0272] When an item of work has been completed and is ready for acceptance

inspection and testing the customer will request quality personnel to perform the acceptance inspection and testing. The quality personnel then performs the testing, the conforming results of the testing and an acceptable inspection will constitute acceptance of the work element being considered for acceptance. When acceptance is not achieved a corrective actions for the noted deficiency will be identified prior to the start of the next operation. This inspection does not constitute final acceptance. Deficiencies noted during the inspections will be identified and documented so a follow-up inspection can be performed. Work that has not been accepted cannot be progressed for payment.

[0273] Although the invention has been described with reference to specific embodiments, this description is not to be construed in a limiting sense. Various modifications of the disclosed embodiments, as well as alternative embodiments, will be apparent to persons skilled in the art. It is, therefore, contemplated that the appended claims will cover all modifications that fall within the true scope of the invention.

CLAIMS:

What is claimed is:

1. A construction management system, comprising: a handheld computer adapted to collect construction quality data from the field; a planning system to track budgetary information; a design system to perform site engineering assessment; and a construction system to track material consumption and progress for each project, the construction system adapted to receive quality data collected from the handheld computer, store daily project reports and generate key indicator reports.

2. The system of claim 1, wherein the handheld computer collects

work in
progress data.

3. The system of claim 1, wherein the handheld computer collects project and
contract identification, inspector identification, item number, location, and
one or more description of activities.

4. The system of claim 1, wherein the handheld computer collects labor related
information.

5. The system of claim 1, wherein the handheld computer collects labor type,
quantity and hours.

6. The system of claim 1, wherein the handheld computer collects equipment
information.

7. The system of claim 1, wherein the handheld computer collects equipment
type, quantity, hours in use and stand-by hours.

8. The system of claim 1, wherein the handheld computer collects submittal
information.

9. The system of claim 1, wherein the handheld computer collects weather
condition, comments, and an inspector name.

10. The system of claim 1, wherein the handheld computer hot-syncs collected
information to a server.

11. The system of claim 10, wherein the collected information is hot-synced
wirelessly using a wireless handheld unit.

12. The system of claim 10, further comprising a modem coupled to the handheld
computer, wherein the information can be hot-synced using a modem.

13. The system of claim 10, further comprising a hot-sync cradle coupleable to
the handheld computer, the cradle hot-syncing the collected information for
transmission to a server.

14. A method for managing a construction project, comprising: collecting construction data from the field with a handheld computer; tracking budgetary information using a planning system; performing site engineering assessment using a design system; and tracking material consumption and progress for each project using a construction system, the construction system adapted to receive data collected from the handheld computer, store daily project reports and generate key indicator reports.

15. The method of claim 14, further comprising collecting work in progress data using the handheld computer.

16. The method of claim 14, further comprising collecting labor related information using the handheld computer.

17. The method of claim 14, further comprising collecting equipment information using the handheld computer.

18. The method of claim 14, further comprising collecting submittal information using the handheld computer.

19. The method of claim 14, wherein the handheld computer collects project and contract identification, inspector identification, item number, location, one or more description of activities, labor type, quantity, hours, weather condition, comments, and an inspector name.

20. The method of claim 14, further comprising hot-syncing collected information to server over land-line or wireless medium.

21. The method of claim 14, further comprising collecting field testing information using the handheld computer.

22. The method of claim 14, further comprising collecting quality assurance testing information using the handheld computer.